sexual" brood in Table II. Sections showed that the females have only very small, rudimentary ovaries, while no trace of a testis could be found in any of the males examined. Externally the flies appeared to be normal in every way, and the sterile males could be distinguished from females with a hand lens, by the coloration and other characters of the end of the abdomen, as in normal specimens. The preparations were made by serially sectioning the entire abdomen, in which process the hard copulatory organs, especially of the male, were always more or less torn and therefore can not be reconstructed; but from the fact that sterile males and females were observed to copulate with one another and with normal individuals it seems fairly certain that the copulatory apparatus of the sterile flies is normal. We thus have another example of development of the sexual instinct, and at least some of the external secondary sexual characters, independently of the gonads; and some additional evidence of independent differentiation of the copulatory structures.

Though the factor which caused the production of these unisexual, sterile broods was not discovered, there seems to be no reason why it should not turn up again; and it may be worth while for those engaged in breeding *Drosophila* to be on the lookout for a repetition of the occurrences above recorded, in view of their possible importance as bearing on sex-determination in general.

L. S. QUACKENBUSH

TWENTY-SECOND ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA

THE first session of the twenty-second annual meeting of the Geological Society of America, held at Boston and Cambridge, Mass., December 28–31, 1909, was called to order at 10 o'clock A.M., on Tuesday, December 28, in the lecture hall of the department of geology, University Museum, Cambridge, Mass., by Vice-president Adams, in the absence, on account of illness, of President Gilbert. In the course of the meeting the following program was offered:

The Post-Tertiary History of the Lakes of Asia Minor and Syria: ELLSWORTH HUNTINGTON, New Haven, Conn.

A study of the lakes of the Anatolian Plateau and of Syria was one of the chief objects of the Yale Expedition of 1909. The lakes fall naturally into five groups, namely, normal fresh-water lakes with ordinary outlets, salt lakes of the common type without outlets, karst lakes with underground outlets in limestone regions, glacial lakes with no definite outlets, but kept fresh by underground seepage, and crater lakes with similar indefinite outlets. In Syria the number of lakes is small, there are no glacial lakes and the other four types are sharply differentiated. The most interesting problems are, first, the part played by lava flows and deltaic deposits in the formation of Lakes Huleh and Galilee, and, second, the former outlet of the Dead Sea and the fluctuations to which this lake has been subject in Post-Tertiary times. In Anatolia the number of lakes is large and the various types merge into one another. For instance, crater lakes are sometimes saline, normal lakes have in some cases been drained by underground outlets, and salt lakes have in the past overflowed and been fresh. A comparison of the ancient strands and deposits of the lakes of both regions affords abundant data for the reconstruction of the varied climatic history of western Asia since the close of the Tertiary era.

Discussed by W. M. Davis, F. P. Gulliver, A. W. Grabau, D. W. Johnson and Joseph Barrell, with reply by the author.

Oscillations of Alaskan Glaciers: R. S. TARR and LAWRENCE MARTIN, Ithaca, N. Y., and Madison, Wis.

The National Geographic Society's Alaskan Expedition of 1909 observed the following glacial oscillations. In Yakutat Bay the Marvine lobe of Malaspina Glacier and the Atrevida, Haenke and Variegated glaciers have ceased the advance which began in the winter of 1905–6. The Hidden Glacier has advanced over two miles since 1906, but has now begun to shrink away from the new shore moraines. The Lucia Glacier is newly crevassed and advancing this summer, and is riding up on a nunatak. These oscillations confirm the earthquake-avalanche theory for glacial advance, proposed in 1906 by the senior author, and furnish facts as to the brevity of such advances. On the lower Copper River the Childs Glacier was more active in 1909 than 1908, but the position of the front remains unchanged. The Miles, Childs and Baird glaciers are essentially as in 1884, 1885, 1891 and 1900. In eastern Prince William Sound

the Valdez and Shoup glaciers are slowly receding. The Columbia Glacier has advanced rapidly since 1908 and is building moraines and destroying the forest, as was observed by Professor U. S. Grant early in 1909 and by the National Geographic Society expedition later in the season. The events in the glaciation of Prince William Sound differ decidedly from those in the Yakutat Bay region.

Discussed by François E. Matthes.

Some Effects of Glacier Action in Iceland: FRED E. WRIGHT, Washington, D. C.

For the study of both glacial and volcanic phenomena Iceland is unique. Extensive remnants of its former ice cap still exist, while its land areas now free of ice are large and without forest cover and are admirably adapted for the physiographic study of the effects of glacier action, both of the continental ice sheet and also the valley glacier types. In a country covered by an ice cap, the surface of the ice sheet is an important plane of reference, which in its physiographic effect is often similar to that of a water surface, as sea level, toward which all exposed land surface tends to be reduced. Mountains and rock cliffs above the ice sheet undergo rapid changes in temperature, with accompanying shattering due to expansion of included moisture on freezing and tend to break down rapidly and to be reduced to the level of the ice surface. Beneath the ice cap, on the other hand, ice erosion tends to accentuate the differences in elevation by cutting deeper into the existing valleys, especially if these lie in the direction of the main ice flow, while the mountain tops, nearer the surface of the ice sheet and consequently under less pressure and of gentler gradient, are eroded less than other areas. The net result of such action, if continued long enough, would be to reduce the mountain peaks to about the same general elevation, so that taken together they would eventually resemble an old uplifted and dissected base level of erosion.

Discussed by W. M. Davis.

The Cliff Sculpture of the Yosemite Valley: F. E. MATTHES, Washington, D. C. (Introduced by M. R. Campbell.)

The Yosemite Valley may be epitomized as a glacial canyon laid in structurally aberrant materials. It is to the latter circumstance chiefly that the valley owes its remarkable wealth of sculptured forms. These are not inherently a product of either stream or ice erosion—they are a function of the structure of the country rock. The granites of the Yosemite region may be pictured as consisting of many huge monolithic masses imbedded in a matrix of more or less strongly fissured rock. This unusual structural habit naturally carries with it extreme inequality of resistance to disintegration. As a consequence, rock structure has played a prominent rôle in the evolution of the topography of the region. The Yosemite landscape indeed reflects in its features the structural character of the materials from which it has been carved: its dominating heights consist invariably of intractable monoliths, its canyons and gulches are due to zones of easily eroded fissile rock. The glacial cross cliffs and lake basins in the valley floors, the headlands and embayments of the rock walls, have in each case evolved in obedience to local structural controls. The very trend and profile of each cliff has been determined by structural planes. Indeed, every rock form and monument of the valley is to be interpreted as an expression of its associated structures. This applies also to those notches and niches about the waterfalls which have heretofore been explained as the result of the shifting of the falls in glacial times.

Further Light on the Gorge of the Hudson: JAMES F. KEMP, New York, N. Y.

The paper gave the latest evidence furnished by the deep borings in the Hudson Valley at the Storm King crossing of the New York City aqueduct, and cited the results of the Pennsylvania Railroad tunnels opposite Thirty-third Street, New York, made public through Dr. E. O. Hovey. The facts were interpreted and involved the general problem of glacial over-deepening. The paper practically continues one by the writer in the *American Journal of Science* for October, 1908, p. 301.

Discussed by J. W. Spencer with reply by the author.

The Richmond Bowlder Trains: F. B. TAYLOR, Fort Wayne, Ind.

The paper described the well-known trains of bowlders of amphibolite schist which extend southeastward into southwestern Massachusetts from "The Knob," formerly called Frye's Hill, which is on the line between the towns of New Lebanon and Canaan in the northeastern part of Columbia County, N. Y. The hill is about nine miles west of Pittsfield, Mass. The train which has been described heretofore and which was visited by Sir Charles Lyell many years ago is composed of large angular blocks strewn along a line running southeast from Frye's Hill. It takes a nearly straight course over mountain and valley with but little curvature or interruption for about

seven miles and is faintly traceable for about twice this distance. Another train, not previously described, but composed of bowlders of the same rock and probably derived from the same source, extends about sixteen miles directly south from Frye's Hill. This train is not so well defined, it is more diffuse and has not yet been traced through the whole distance. Although apparently the same rock, these bowlders are all well rounded and show more weathering than the angular blocks. The relations and apparent significance of these separate trains were briefly discussed.

Shorelines of the Glacial Lakes in the Oberlin Quadrangle, Ohio: FRANK CARNEY, Granville, Ohio.

The paper described the varying features shown in the shorelines of the Maumee, Whittlesey and Warren lake stages, and discussed the factors involved.

Isobases of the Algonquin and Iroquois Beaches and Their Significance: JAMES WALTER GOLDTHWAIT, Hanover, N. H. (Introduced by F. B. Taylor.)

During the past five years, instrumental measurements of altitude of the raised beaches of Lake Algonquin in Illinois, Michigan, Wisconsin and the province of Ontario, have provided new data for the construction of isobases of elevation of the Algonquin beach in an area 450 miles east and west by 300 miles north and south. These measurements not only fix the identity of the Algonquin beach throughout that region, but disclose the exact direction and rate of post-Algonquin tilting at all places within it. It is possible, moreover, to fix the position of an "isobase for zero," or "hinge line," northeast of which there has been differential uplift, but southwest of which no uplift since the making of the Algonquin beach. This horizontal portion of the water-plane is believed to indicate the original height of Lake Algonquin and serves as a datum plane from which to compute the amount of uplift of more northerly localities. On the basis of measurements by Spencer, Gilbert, Coleman and Fairchild on the Iroquois beach, isobases are drawn for that plane over Lake Ontario. The Iroquois and Algonquin planes are then compared. These conclusions are reached: (*a*) that these two stages of the neighboring lakes were nearly contemporaneous, but that the Iroquois is probably somewhat older; (*b*) that the differential uplifts in which the Algonquin-Iroquois region participated, although of well-nigh continental extent, were here (as in the case of Lake Agassiz) of wonderful regularity, and (*c*) that whether due to isostacy or not, the uplifts centered in the Laurentian oldland, and the isobases bear a significant relation to its border, as DeGeer pointed out nineteen years ago.

The paper was discussed by J. W. Spencer, Frank Carney and F. B. Taylor, with reply by the author.

The Diversion of the Montreal River: ROBERT BELL, Ottawa, Canada.

This paper described a remarkable example of change in the destination of a large river in which the stream has been diverted in post-glacial times into a new channel that carries its waters all the way to its present mouth in a straight course of 90 miles, which lacks only 45° of being exactly opposite to that of the upper part of the stream, as well as its former continuation below the point at which the change took place; that is to say, that at a certain point the course of the river was turned round through an angle of not less than 135°, or from a north to a southeast direction, and made finally to discharge into the Atlantic Ocean instead of Hudson Bay. This singular occurrence was rendered possible from the fact that in one part of its course the river was barely able to pass across what has now become a low divide, and that a slow rising or tilting of the land to the southward gradually stopped the northward flow of the river, while at the same time the changing conditions induced a process of "stream-robbing" through a dam of loose drift material a short distance east of this increasing obstruction. The paper described numerous facts, which, taken together, seem to prove the manner in which this important and interesting phenomenon was accomplished.

On the Relative Work of the Two Falls of Niagara: J. W. SPENCER, Washington, D. C.

This paper should be considered as an additional chapter to "The Evolution of the Falls of Niagara," by the writer, wherein the work of the smaller cataract and the relative efficiency were scarcely considered. The American Falls carry only five per cent. of the total discharge, and are now some 50 feet lower than formerly, with the recession, as affected by the talus, undeterminable by measurement, but calculated at 0.27 foot a year, as probable. The removal of the fallen masses of limestone beneath the main cataract, below a depth of 72 feet, appears to be largely by solution. By soundings, experiment and calculation it is found that approximately a third of the periodic law, on an increasing helix, on a half

mechanical effect is lost in the cushion of water below the falls, which thereby balances any lesser efficiency of the smaller falls, which strike directly on the talus below. In the variable energy, the power of deepening the pool beneath a waterfall seems to act as a mean balancing medium, so that there is found no reason for deviating from the laws of erosion in the changes at Niagara, until some unexpected discovery shall be made. So far, the author has been unable to find any grounds, based upon observation, for greater variation in the approximate age of Niagara than those provided for.

Natural Bridges of North America with a Discussion of Their Origin: Herdman F. Cleland, Williamstown, Mass.

A. Natural bridges initiated by stream erosion.
   1. By the perforation of the neck of an incised meander.
   2. By pot-hole action.
   3. By erosion assisted by frost action. (Yellowstone.)
   4. Travertine-cemented stream deposits undercut by stream action.
   5. By the undercutting of a petrified log.
   6. By the headward cutting of two streams.

B. Bridges initiated by wave erosion.
   1. Certain wave-cut arches.

C. Bridges initiated by solution.
   1. By seepage through a joint or other crack, thence along a bedding plane and discharging under a fall or rapid.
   2. Caving in of the roof of a cavern.

D. Bridges formed by gravity.
   1. A stone wedged in a narrow chasm.
   2. A slab separated from one bank and fallen over to the other.

E. Bridges formed by deposition.
   1. Snow and ice bridges.
   2. Travertine bridges and bridges formed by the cementation of stream bowlders which have afterwards been partly cut through by erosion.

Summary:
   1. Character of rock in which bridges occur.
   2. Stage of development of the region in which they occur.
   3. In glaciated and non-glaciated regions.
   4. Summary of origin.

Discussed by H. C. Hovey and J. W. Spencer.

Geological Suggestions Derived from a New Arrangement of the Elements: B. K. Emerson, Amherst, Mass.

The elements were arranged in the order of the octave, two octaves and four double octaves, and interesting physical and geological relations were brought out.

New Light on the Geology of the Wasatch Mountains: Eliot Blackwelder, Madison, Wis.

The past season's work of the U. S. Geological Survey in the Wasatch and Bear River Ranges of Utah, has added several facts of importance to the current interpretation of the structure and stratigraphy of the region. The Weber quartzite thins rapidly north and northwest of the type locality and there is evidence indicating that this thinning has been caused by erosion during the Pennsylvanian period. The Ogden quartzite appears to be neither Devonian, as first reported, nor Ordovician, as stated in more recent years, but merely a repetition of the lower Cambrian quartzite upon a large overthrust. The great body of "Wasatch quartzite" of the King Survey was found to be separated from the known Cambrian quartzite by a distinct although readily overlooked unconformity. Structurally the Wasatch range proves to be more than a simple monocline with local folds. Near Ogden there are several large overthrusts and a number of subsequent transverse normal faults, one of which has an unusually large displacement.

Discussed by S. F. Emmons, Bailey Willis, A. W. Grabau, Arthur Keith and the author.

Hawaiian Volcanoes: Reginald A. Daly, Boston, Mass.

Evidence was given for the view that the vent at Kilauea is an opening in the roof of a large laccolith. This conception offers a tentative explanation of the observed independence of Halemaumau and Mokuaweoweo (Mauna Loa). A small, visible laccolith on Hawaii was then described. The paper also included a discussion of (*a*) the method by which the heat is maintained in Halemaumau; (*b*) the differentiation of Mauna Kea alkaline rocks from basaltic magma; and (*c*) the development of Mauna Kea in its present form.

Discussed by T. A. Jaggar, Jr.

Genetic Classification of Active Volcanoes: T. A. Jaggar, Jr., Boston, Mass.

The author has studied seven active volcanoes in last eight years. Mercalli's classification by types of eruption and kinds of lavas is not genetic and hence contains many overlaps. Volcanoes show kinship of origin and stages of growth related to a common origin. It is believed that a classification based on (1) the unity of all

volcanic phenomena and (2) diversity of types measured by viscosity of lavas, will produce a rational and significant series. This series was shown in tabular form.

Tarumai, a Cumulo-volcanic Eruption in Japan, 1909: T. A. JAGGAR, Jr., Boston, Mass.

This volcano is in southeastern Yezo. It became active January 11, 1909, with culminating eruption April 12. Between April 12 and April 23, an extraordinary, hard lava dome, a phenomenon hitherto unknown in Japan, rose within the crater. The volcano otherwise is a cinder cone. Size, shape and mechanism of the dome resemble Pelée and Bogoslof. The writer visited the volcano in May, 1909, accompanied by Japanese geologists, and obtained photographs which were shown.

The discussion of Dr. Jaggar's two papers was participated in by E. O. Hovey, W. M. Davis, F. L. Ransome, R. A. Daly, Bailey Willis, F. E. Wright, Ernest Howe and the author.

The Alaskan Earthquakes of 1899: LAWRENCE MARTIN, Madison, Wis. (Introduced by R. S. Tarr.)

Severe tectonic earthquakes in Alaska in September, 1899, accompanied faulting, tilting and warping in the Yakutat Bay region. There were shocks for twenty-seven days, including five or six world-shaking disturbances and hundreds of minor shocks. On one day there were over fifty minor shocks and two world-shaking disturbances. These were recorded by seismographs throughout the world. In Alaska, Yukon Territory and British Columbia the shocks of September 3 and 10 were felt throughout an area of at least 217,000 square miles on the land, and perhaps as much as a million and a half square miles on the ocean. Only twenty thousand persons were in the area affected, two hundred and fifty close to the earthquake origin, and eight men right on one of the faults, but there was no loss of life and insignificant damage to property.

Structure of the Northern Portion of the Burning Springs—Volcano Anticline, in Pleasants, Wood and Ritchie Counties, West Virginia: F. G. CLAPP, Pittsburgh, Pa.

A careful geological examination of the northern portion of this anticline and plotting its structure on the government topographic maps shows that the anticline is not even approximately straight or of uniform height nor width, as has generally been assumed by geologists and oil operators, but is very irregular. The strike of the anticline ranges from N. 20° E. to N. 10° W. The width of its flat crest ranges from an eighth to half a mile, while the maximum altitude of any given formation on the axis varies several hundred feet in different portions of the anticline, thus making a series of alternating domes and saddles. Since the oil development here is largely a matter of the past, the relations of the oil pools to the structure can be well studied. It was found that the productive portions of the anticline correspond closely with the domes, while between these saddles were always barren of oil for distances of sometimes over two miles along the axis. As a rule the shallower oil sands are productive on an anticlinal crest, while the deeper ones are dry there, but productive farther and farther from the crest, according to relative depth.

Discussed by I. C. White.

A Generalized Section through the Appalachian Mountains of Maryland: CHARLES K. SWARTZ, Baltimore, Md.

This paper presented a generalized section through the Appalachian Mountains of Maryland, together with a discussion of certain principles of Appalachian structure. A generalized section was given through the Appalachian Mountains on the Maryland-Pennsylvania state line, with a detailed section through the central Appalachians. It was shown that there are certain principles of Appalachian structure which characterize the region discussed, and which apply to the general structure of the Northern Appalachians. The question of the origin of canoe-shaped folds was then discussed briefly. Finally, the relation of the drainage system to the structure was considered.

Discussed by Arthur Keith, A. H. Purdue and the author.

Some Instances of Flowing Wells on Anticlines: F. G. CLAPP, Pittsburgh, Pa.

Several unrecorded flowing artesian wells of a peculiar type were described. The flows are from unproductive oil wells in the northern Appalachian region. The first-mentioned instance is on the Burning Springs-Volcano anticline in Pleasants County, W. Va. This anticline consists of an alternating series of saddles and domes, and the flowing wells are situated on a saddle of the anticlinal crest situated midway between two domes. The source of the water is one of the Carboniferous sandstones, which does not rise high enough in the anticline to give the requisite head, the latter being presumably due to pressure transmitted to the water in the sandstone from overlying porous formations in the domes of the anticline. The second instance is in Beaver

County, Pa. The wells are situated high up on the flank of the Frederickstown anticline. The water comes from depths of less than 100 feet and overflows between the drive pipe and the casing of the wells, the head being due to pressure transmitted from more superficial formations in near-by hills. Analogous instances of transmitted pressure were cited from the state of Indiana.

Discussed by A. C. Lane.

Local Anticlines in the Chagrin Shales at Cleveland, Ohio: Frank R. Van Horn, Cleveland, O.

Owing to grade crossing eliminations during the preceding summer, considerable excavation has been done along the line of the New York, Chicago and St. Louis Railroad between Cedar Avenue and Mayfield Road. The rock is Chagrin shale of the upper Devonian, and many flexures, with limbs ranging from three to ten feet long, were observed. The disturbance rarely extended more than fifteen feet below the surface and passed into horizontal shale at the bottom and sides of the anticlines, indicating that the motion was of local origin. In most cases the folds are below the limit of frost action, and it is believed that they have been formed by local pressures due to the alteration of pyrite or marcasite, which are fairly constant constituents of the shales. The formation of ferrous sulphate would require a threefold increase in volume, which should cause sufficient pressure to produce the anticlines at points where the sulphides were more concentrated.

Discussed by H. L. Fairchild.

An Experimental Investigation into the Flow of Diabase: Frank D. Adams, Montreal, Canada.

A paper presenting the results of an investigation into the flow of marble was presented at the Montreal meeting. Since that time the investigation has been continued under a grant from the Carnegie Institution, the work being extended to a study of impure limestones, dolomites and various silicate rocks. The present paper presented the results of an experimental study of the deformation of a typical diabase. This deformation was carried on at various pressures and at temperatures ranging as high as 1,000° C. The resulting structures induced in the diabase are described and compared with those presented by rocks which have suffered deformation through movements in the earth's crust.

Discussed by H. F. Reid, Bailey Willis and the author.

Connate Waters of the Atlantic Coast: Alfred C. Lane, Tufts College, Mass.

In previous papers before this society, the Lake Superior and Canadian Mining Institutes, the author has called attention to the possibility of admixtures of connate (originally buried) waters in underground waters, especially in the Lake Superior region. Waters of the Atlantic coast seem also to show such admixture, sometimes of an ocean higher in calcium chloride than the present.

Changes Produced on Springs by a Sinking Water Table: T. C. Hopkins, Syracuse, N. Y.

The past two seasons have been exceptionally dry in central New York. The water table has consequently sunk lower than for many years. Besides the drying up of many springs, wells and streams, some of them have changed the kind of mineral matter held in solution. A spring at Edwards Falls, near Manlius, was a calcareous spring until last year, when it gave off considerable sulphur. This year it is giving off both sulphur and iron oxide. Another spring four miles south of Syracuse has changed from a calcareous to a sulphur spring during the same time.

Criteria for the Recognition of Various Types of Sand Grains: W. H. Sherzer, Ypsilanti, Mich.

Microscopic studies of sand grains lead to the conclusion that typical grains of glacial, beach or river, dune and desert origin may be recognized with considerable certainty. These characteristics relate to the composition, actual and relative size, shape, surface, appearance, etc., and when taken in conjunction with certain stratigraphic features may throw light upon the geological history of the sand rocks. An illustration was furnished by the Sylvania sandstone which is known in outcrop and by means of borings about the western half of Lake Erie.

Discussed by Joseph Barrell, A. C. Lane and W. M. Davis.

Climate and Physical Conditions of the Keewatin: A. P. Coleman, Toronto, Canada.

Glacial conditions prevailed at the beginning of the Huronian, but hitherto less has been known of the climate of the Keewatin. It is often referred to as essentially eruptive and with very different conditions from the present—hot seas, etc. In Ontario, where the Keewatin is best displayed, it often includes thousands of feet of ordinary sediments, not only the puzzling iron formation, but carbonaceous slate, ordinary slate, arkose, sedimentary mica schist and gneiss and crystalline limestone. The eastern Grenville series, in part probably equivalent to the Keewatin, includes similar rocks, but with far more limestone. It is essentially a sedimentary series. Most of the

eruptives of the Keewatin are surface volcanics or ash rocks. The sedimentary rocks imply land and sea, cool waters in which life existed, and in general climates and conditions like the present. As these are the oldest known rocks, there is no geological evidence that the surface of the earth was ever too hot to allow water and life to exist. Geologists and astronomers should bear this in mind in their theories.

Discussed by W. G. Miller, H. F. Reid, W. M. Davis and the author.

With permission from the society, an overture from the American Philosophical Society was then read, asking for encouragement of a plan for American exploration in the Antarctic regions.

On motion, the communication was referred to the council for consideration and report back to the society.

Then was presented:

Theory of Isostacy: W. M. DAVIS, Boston, Mass. Discussed by H. F. Reid.

The Mechanics of Faults: HARRY FIELDING REID, Baltimore, Md.

The forces which can be considered as active in producing faults are: horizontal tensiens and compressions; vertical forces (upwards or downwards) and horizontal drags on the under surface of the crust. It was shown that, in a uniform crust, horizontal forces alone would produce normal or thrust faults having hades of 45°; that the available vertical forces alone would produce normal faults with a smaller hade, and that the addition of a tension to a vertical force increases the hade, whereas the addition of a pressure diminishes it. Drags will generate pressure and tensions; they may cause faults with horizontal displacements. The elevation of large regions is due to vertical and not to tangential forces.

On the Relationship of Niagara River to the Glacial Period: J. W. SPENCER, Washington, D. C.

In the borings made in the Whirlpool-St. Davids channel, there have been discovered the remains of a cool-climate forest and soil at a depth of 186 feet below the surface, with the proof of three or four glacial advances since that time, nearly like the Pleistocene history at Toronto. Before the cool epoch, named "Forest Glen," at least two glacial epochs have left their remains in the buried channel, which is further filled a hundred feet, or perhaps two hundred, of which some of the deposits may represent a still older epoch; so that the preglacial origin of the buried gorge, requiring an enormous lapse of time (of perhaps millions of years) is indicated. The age of the modern Niagara River is also seen to be younger than the glacial deposits about the western end of Lake Ontario, though not as recent as those of the latter Wisconsin epoch in other localities.

Discussed by Lawrence Martin, F. B. Taylor, W. M. Davis and the author.

Partial Drainage of Niagara Falls in February, 1909: J. W. SPENCER, Washington, D. C.

The publication of this paper is a record through photographs taken by the writer of phenomena which may occur again. The whole of the 1,000 feet of the American Falls, 800 feet of the main cataract adjacent to Goat Island and 200 feet next to the Canadian shore (where already there had been a curtailment of 415 feet, owing to power diversion) were drained. The causes were: the permanent lowering of the basin above Goat Island by about 18 inches, since 1890; the low water of Lake Erie at the time, and strong northerly wind during very cold weather.

The Origin of Cliff Lake, Montana: G. R. MANSFIELD, Evanston, Ill. (Introduced by U. S. Grant.)

Cliff Lake lies in south central Montana about five miles northwest of the continental divide, where the latter makes the pronounced bend that partly encloses the basin of Lake Henry in eastern Idaho. The lake was brought to public notice in 1872 by Hayden, who described it as formed in a volcanic fissure. At the present time popular belief ascribes the lake to a similar origin. The paper discussed the evidence for the hypothesis of volcanic origin and presents alternative evidence to show that the lake, though set deeply in a lava plateau, really occupies a portion of a river valley that was interrupted in early maturity by the advent of a glacier which left a series of morainic dams and thereby produced a group of small lakes, of which Cliff Lake is perhaps the most notable.

Discussed by W. M. Davis and the author.

The Rock Streams of Veta Mountain, Colorado: H. B. PATTON, Boulder, Colo.

Veta Mountain is an isolated, ridge-like mountain some ten miles east of the southern end of the main Sangre de Christo Range. It stands some two thousand feet above its base and has extremely steep slopes. On the west side of the mountain are to be found two remarkable rock streams that afford excellent opportunities of studying the nature and origin of these interesting physiographic features. The streams were described in detail and their origin discussed.

Discussed by D. W. Johnson, F. E. Matthes, W. M. Davis and the author.

Meanders and Scallops: MARK JEFFERSON, Ypsilanti, Mich.

Meanders, or balanced swings in river courses, occur from source to mouth, though most fully developed in the plains part. The embayments or scallops produced in their upper course by meanders that come in contact with the bluff are of identical measurement with the meanders and serve to estimate the ancient volume of the stream.

Beach Cusps: MARK JEFFERSON, Ypsilanti, Mich.

Beach cusps are the points of gravel or sand that occur at times on almost all beaches where these materials exist. Perspective foreshortening gives them a fictitious appearance of regularity. They are caused probably in various ways, by waves that play squarely on shore, either under on-shore winds, or in still weather after storms when the diminishing waves accommodate themselves more and more to the shape of the bottom and the configuration of the shore.

Beach Cusps: D. W. JOHNSON, Cambridge, Mass.

This paper presented the results of studies of beach cusps found on various types of shorelines. The character and occurrence of the cusps were described. Several theories advanced by previous writers to account for the formation of the cusps were reviewed, but do not seem competent to explain the observed phenomena. An alternative theory was proposed, which receives support from the artificial production of beach cusps.

A Progress Geological Map of Oklahoma: C. N. GOULD, Norman, Okla.

The paper indicated by means of charts and otherwise the work that has been and is now being done in the study of the geology of the state.

Discussed by Arthur Keith.

Salt Marsh Formation near Boston, and its Geological Significance: CHARLES A. DAVIS, Washington, D. C. (Introduced by David White.)

A description of some of the salt marshes near Boston, including newly discovered facts regarding the way in which they are formed and their bearing on geological history. These marshes have not been formed in depressions behind barrier beaches as the result of filling by plants and sediments in the resulting ponds, but have quite a different origin which is plainly indicated in their structure, and in the character of the plant material contained in them. The marshes contain easily interpreted records of a continued postglacial coastal subsidence that is still going on at a steady and uniform rate that it is possible to determine. The interpretation of these deposits also has an important bearing on the theories of formation of coal.

Remarks were made by A. W. Grabau.

Observations on Rate of Sea Cliff Erosion: CHARLES P. BERKEY, New York, N. Y.

The Permo-carbonic Conglomerates of South Brazil: J. B. WOODWORTH, Cambridge, Mass.

The bowlder-bearing Permian beds of south Brazil for which Derby proposed a glacial origin in 1888, and sagaciously likened to the deposits of India, were searched in 1908 for evidences of glaciation not previously found. Striated stones including probable fragments of disrupted glaciated flows were found in tillite beds on the Rio Jaguaricatu in northern Parana, and similar phenomena, especially striated stones, in the states of Sao Paulo and Santa Catharina. Much of the bowlder-bearing group demands floating ice at sea-level, as shown by a depauperated marine fauna between bowlder beds in the valley of the Rio Negro. Certain tillite beds seem best explained as ice-laid deposits derived from an easterly source through ice-action capable of disrupting and transporting seaward certain readily recognized rocks of the series inferior to the glacial beds. The paper as presented was illustrated by stereopticon views showing geology and topography of the area, as a part of the results of the first Shaler Memorial Expedition.

Discussed by Bailey Willis and I. C. White.

Age of the "Calciferous" Formation of the Mohawk Valley, N. Y.: E. O. ULRICH and H. P. CUSHING, Washington, D. C., and Cleveland, O.

The Little Falls dolomite of the Mohawk Valley is found to consist of two distinct formations, the lower a dolomite formation of Ozarkian age, the upper a limestone of lower Beekmantown age, with a distinct unconformity between the two. The Beekmantown thins to the west so that west of Little Falls, the Lowville lies on the Ozarkian. The unconformity can be followed into the Champlain Valley, reappears in the St. Lawrence region, and is believed to mark the line of division between the two formations everywhere in northern New York. Locally, about Saratoga, a very fossiliferous limestone lens appears in the basal portion of the dolomite formation.

EDMUND OTIS HOVEY,
Secretary

(To be continued)